AD NO. ___________________________
DTC PROJECT NO. 8-CO-160-UXO-021
REPORT NO. ATC-8834

STANDARDIZED

UXO TECHNOLOGY DEMONSTRATION SITE

BLIND GRID SCORING RECORD NO. 431

SITE LOCATION:
U.S. ARMY YUMA PROVING GROUND

DEMONSTRATOR:
G-TEK AUSTRALIA PTY LIMITED
3/10 HUDSON STREET
ALBION QLD 4010 AUSTRALIA

TECHNOLOGY TYPE/PLATFORM:
TM-4 MAG ARRAY/MAN PORTABLE

PREPARED BY:
U.S. ARMY ABERDEEN TEST CENTER
ABERDEEN PROVING GROUND, MD 21005-5059

JUNE 2005

Prepared for:
U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MD 21010-5401

U.S. ARMY DEVELOPMENTAL TEST COMMAND
ABERDEEN PROVING GROUND, MD 21005-5055

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14. ABSTRACT
This scoring record documents the efforts of G-TEK Australia PTY Limited to detect and discriminate inert unexploded ordnance (UXO) utilizing the YPG Standardized UXO Technology Demonstration Site Blind Grid. The scoring record was coordinated by Larry Overbay and by the Standardized UXO Technology Demonstration Site Scoring Committee. Organizations on the committee include the U.S. Army Corps of Engineers, the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program, the Institute for Defense Analysis, the U.S. Army Environmental Center, and the U.S. Army Aberdeen Test Center.

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SECTION 1. GENERAL INFORMATION

1.1 BACKGROUND

Technologies under development for the detection and discrimination of unexploded ordnance (UXO) require testing so that their performance can be characterized. To that end, Standardized Test Sites have been developed at Aberdeen Proving Ground (APG), Maryland and U.S. Army Yuma Proving Ground (YPG), Arizona. These test sites provide a diversity of geology, climate, terrain, and weather as well as diversity in ordnance and clutter. Testing at these sites is independently administered and analyzed by the government for the purposes of characterizing technologies, tracking performance with system development, comparing performance of different systems, and comparing performance in different environments.

The Standardized UXO Technology Demonstration Site Program is a multi-agency program spearheaded by the U.S. Army Environmental Center (AEC). The U.S. Army Aberdeen Test Center (ATC) and the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program (ESTCP), the Strategic Environmental Research and Development Program (SERDP) and the Army Environmental Quality Technology Program (EQT).

1.2 SCORING OBJECTIVES

The objective in the Standardized UXO Technology Demonstration Site Program is to evaluate the detection and discrimination capabilities of a given technology under various field and soil conditions. Inert munitions and clutter items are positioned in various orientations and depths in the ground.

The evaluation objectives are as follows:

a. To determine detection and discrimination effectiveness under realistic scenarios that varies targets, geology, clutter, topography, and vegetation.

b. To determine cost, time, and manpower requirements to operate the technology.

c. To determine demonstrator's ability to analyze survey data in a timely manner and provide prioritized "Target Lists" with associated confidence levels.

d. To provide independent site management to enable the collection of high quality, ground-truth, geo-referenced data for post-demonstration analysis.

1.2.1 Scoring Methodology

a. The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}), and those that do not correspond to any known item, termed background alarms.

b. The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the blind grid RESPONSE STAGE, the demonstrator provides the scoring committee with a target response from each and every grid square along with a noise level below which target responses are deemed insufficient to warrant further investigation. This list is generated with minimal processing and, since a value is provided for every grid square, will include signals both above and below the system noise level.

c. The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such and to reject clutter. For the blind grid DISCRIMINATION STAGE, the demonstrator provides the scoring committee with the output of the algorithms applied in the discrimination-stage processing for each grid square. The values in this list are prioritized based on the demonstrator's determination that a grid square is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For digital signal processing, priority ranking is based on algorithm output. For other discrimination approaches, priority ranking is based on human (subjective) judgment. The demonstrator also specifies the threshold in the prioritized ranking that provides optimum performance (i.e., that is expected to retain all detected ordnance and rejects the maximum amount of clutter).

d. The demonstrator is also scored on EFFICIENCY and REJECTION RATIO, which measures the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. EFFICIENCY measures the fraction of detected ordnance retained after discrimination, while the REJECTION RATIO measures the fraction of false alarms rejected. Both measures are defined relative to performance at the demonstrator-supplied level below which all responses are considered noise, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

e. All scoring factors are generated utilizing the Standardized UXO Probability and Plot Program, version 3.1.1.

1.2.2 Scoring Factors

Factors to be measured and evaluated as part of this demonstration include:

a. Response Stage ROC curves:

(1) Probability of Detection (P_d^{res}).

(2) Probability of False Positive (P_{fp}^{res}).

(3) Background Alarm Rate (BAR^{res}) or Probability of Background Alarm (P_{BA}^{res}).

b. Discrimination Stage ROC curves:

(1) Probability of Detection (P_d^{disc}).

(2) Probability of False Positive (P_{fp}^{disc}).

(3) Background Alarm Rate (BAR^{disc}) or Probability of Background Alarm (P_{BA}^{disc}).

c. Metrics:

(1) Efficiency (E).

(2) False Positive Rejection Rate (R_{fp}).

(3) Background Alarm Rejection Rate (R_{BA}).

d. Other:

(1) Probability of Detection by Size and Depth.

(2) Classification by type (i.e., 20-mm, 40-mm, 105-mm, etc.).

(3) Location accuracy.

(4) Equipment setup, calibration time and corresponding man-hour requirements.

(5) Survey time and corresponding man-hour requirements.

(6) Reacquisition/resurvey time and man-hour requirements (if any).

(7) Downtime due to system malfunctions and maintenance requirements.

1.3 STANDARD AND NONSTANDARD INERT ORDNANCE TARGETS

The standard and nonstandard ordnance items emplaced in the test areas are listed in Table 1. Standardized targets are members of a set of specific ordnance items that have identical properties to all other items in the set (caliber, configuration, size, weight, aspect ratio, material, filler, magnetic remanence, and nomenclature). Nonstandard targets are inert ordnance items having properties that differ from those in the set of standardized targets.

TABLE 1. INERT ORDNANCE TARGETS

Standard Type	Nonstandard (NS)
20-mm Projectile M55	20-mm Projectile M55
	20-mm Projectile M97
40-mm Grenades M385	40-mm Grenades M385
40-mm Projectile MKII Bodies	40-mm Projectile M813
BDU-28 Submunition	
BLU-26 Submunition	
M42 Submunition	
57-mm Projectile APC M86	
60-mm Mortar M49A3	60-mm Mortar (JPG)
	60-mm Mortar M49
2.75-inch Rocket M230	2.75-inch Rocket M230
	2.75-inch Rocket XM229
MK 118 ROCKEYE	
81-mm Mortar M374	81-mm Mortar (JPG)
	81-mm Mortar M374
105-mm HEAT Rounds M456	
105-mm Projectile M60	105-mm Projectile M60
155-mm Projectile M483A1	155-mm Projectile M483A
	500-lb Bomb
	M75 Submunition

JPG = Jefferson Proving Ground.
HEAT = High explosive, antitank

SECTION 2. DEMONSTRATION

2.1 DEMONSTRATOR INFORMATION

2.1.1 Demonstrator Point of Contact (POC) and Address

G-TEK Australia PTY Limited
3/10 Hudson Street
ALBION QLD 4010 Australia

2.1.2 System Description (provided by demonstrator)

The hand-held TM-4 magnetometer (MAG) system consists of the following components:

Item	Manufacturer	Model
Magnetometer Control Module	G-TEK	TM-4
Cs Vapor-type TMI Sensors	Geometrics	G822AS
Base-station Magnetometer	G-TEK	TM-4
DGPS	NovAtel	Rt-2/OEM-4
Odometer	G-TEK	TM-4D

DGPS = Differential Global Positioning System.

The TM-4 is a self-contained magnetometer system that may be configured with up to four optically pumped magnetic sensors, each of which records the total magnetic field intensity in units of nT to a resolution of 0.01 nT. These sensors will be mounted in an array oriented perpendicular to the survey direction, permitting up to four sensor transects to be recorded simultaneously in the open terrain with high survey productivity. The proposed sensor separation is 300 mm and ground clearance, 250 mm. The measurement rate from each sensor is selectable from nominally 50 per second at 0.003-nT resolution to 400 per second at 0.08-Nt resolution. The high measurement rate permits effective real-time filtering of 50 to 60 Hz electromagnetic interference prior to recording position or time-based measurements at intervals appropriate to the application (in this case, 50 mm or 10 Hz). The TM-4 interfaces with both the industry-standard real-time kinematic (RTK) differential Global Positioning System (DGPS) and the proprietary cotton thread-based odometer systems. This provides versatile time or position-based positioning that is adaptable to varied terrain and vegetation conditions. A key attribute of the TM-4 is the operating system software, which provides a continuous set of data quality monitors, reducing the need to resurvey and improving data quality. In particular, audio and graphic displays and alarms monitor the quality of sensor signals and position data as well as aid navigation.

A two-person crew operates the TM-4 system. One person carries the sensor array, to which is attached the DGPS antenna and odometer system. The sensor array measures 1500 mm in length by the array width, which in this case is 900 mm. The quad-sensor array weighs 10 kg. The second person operates the navigation and data acquisition hardware, which is carried in a backpack with batteries. This backpack measures 600 by 400 by 250 mm and weighs approximately 12 kg. The user interface is a hand-held personal computer (PC). A 5-meter cable eliminates interference at the sensors from the other hardware and separates the two operators. No specific safety hazards have been identified with the use of this equipment.

Data processing consists of magnetic base-station subtraction, optional band-pass spatial filtering to enhance particular source depths, grading, and imaging. Interpretation of picked anomalies involves classification (by type) and ranking (by probability UXO) using model inversion involving both magnetic remanence and the use of a database of anticipated UXO types. Products are data images and dig sheets conforming to DID OE-005-05.02 standards.

The TM-4 has been used with our odometer system by industry and Australian Department of Defense operators for more than 14 years, and with the DGPS for more than 7 years. The odometer remains the positioning technology of choice in adverse terrains (such as wooded scenarios); the DGPS is preferred in open environments. Combined, they meet the requirements of most situations.

2.1.2.1 <u>Positioning system description</u>. G-TEK proposes using a combination of the following survey/navigation technologies:

Item	Manufacturer	Model
DGPS	NovAtel	RT-2/OEM-4
Odometer	G-TEK	TM-4D
Polychain	PEKO	100M
Siters	Various	Generic traffic cones, wooden dowels, and flagging

The TM-4 magnetometer system interfaces with both industry-standard RTK DGPS and proprietary cotton thread-based odometer systems, providing versatile time- or position-based positioning that is adaptable to varied terrain and vegetation conditions. In both cases, when a UXO detection standard of survey coverage is required, G-TEK operators use a pre-established control grid and visual sighters for straight-line navigation, and the DGPS or odometer primarily for data positioning.

2.1.2.2 <u>Using DGPS in the open area.</u> Where satellite coverage is reliable, the DGPS is the technology of choice and any of the industry-standard RTK systems may be used, although in this program we propose using the NovAtel RT-2 system (Ashtech Z-Extreme as a backup). Our preference is to establish a Global Positioning System (GPS) base station on a monument that is within 1 km of the survey area and to use a radio link to the roving GPS receiver. In the roving instrumentation, sensor data are time-tagged with GPS time, and the transformed DGPS positions (and the raw National Maritime Electronics Association (NMEA) GPS data for backup) are recorded. In this way, sensor data are positioned in post-processing to achieve a position accuracy of better than 5 cm. Prior to starting the survey, the roving GPS is located at a known reference to confirm the integrity of the system and the transformations used. The TM-4 array, in use in an open area, is shown in Figure 1.

Figure 1. Demonstrator's system, TM-4 MAG array, shown as man portable.

2.1.2.3 <u>Using the odometer in the wooded area</u>. The control grid setup will combine the use of the DGPS and traditional survey techniques. Navigation will be done as described above. However, 5 meters before the start of each new transect, the cotton thread is tied either to vegetation or to a small peg anchored in the ground. When each control line is reached, a distance mark is recorded in the TM-4 prior to moving the cone. At the completion of each survey grid section, the cotton is gathered and removed from the site. In post-processing, linear error distribution delivers positional accuracy that is typically less than 0.1 percent of the distance between control lines (0.1 percent of 25 m delivers 25 mm accuracy, in this case.) Because the odometer is used in more adverse terrain, including forests, protocols have been developed using the electronic notepad facility of the TM-4 for recording the location of obstacles (e.g., trees) and the direction taken around them. Thus, if a UXO is detected close to a tree, for example, the validation team will know which side of the tree to search. Experience over many years surveying in forested conditions has indicated that a root mean square (rms) target position error of less than 300 mm can be anticipated, with the most errors occurring where obstacles are circumvented. These errors are not cumulative and are comparable with the interpreted target position errors achieved using the DGPS.

2.1.3 Data Processing Description (provided by demonstrator)

The data will be processed in the following sequence (the software used at each step is noted in square brackets):

a. Data Acquisition.

(1) The output from up to four sensors of magnetometer data will be recorded at 10 Hz in GPS mode and at 5 cm in cotton odometer distance mode [G-TEK's TM-4 magnetometer acquisition software].

(2) The magnetometer data will be precisely time-tagged, with reference to the connected GPS, at 1 Hz.

(3) The GPS positions and GPS quality information will be logged at no less than 1 Hz in the required coordinate system. Extraneous position data will be either automatically or manually flagged as "not required." Raw, untransformed GPS NMEA standard strings will also be logged as backup [G-TEK's SurvNav].

(4) In cotton odometer mode, the precise vertices of the survey boundary and control lines will be measured with the RTK DGPS and entered into the magnetometer. The operator will be responsible for hitting the start and stop button for each line [G-TEK's TM-4 magnetometer acquisition software].

(5) A magnetometer base station will record time-tagged, stationary, temporal variations at 10 Hz.

(6) All data will be transferred from the field devices to the processing computer, and a Field Data Sheet will be completed by each crew leader (Attachment A, DID OE-005-05.01).

(7) The GPS data will automatically be assigned unique line numbers during the data acquisition. The data will be indexed by these line numbers during the line-based post-processing (i.e., up to the grading stage). Extraneous data will be automatically and manually flagged as "not required" [G-TEK's SurvNav].

b. Post-Processing by the Processing Geophysicist.

(1) The GPS track will be checked, edited, and smoothed as required [GEOSOFT]. For cotton positioning, the distance recorded by the precise electronic odometer will be compared with the expected known length of each line. Variations exceeding a certain tolerance will trigger the issue of a Line-ReDo order to the field crew leader [G-TEK's Distance-Based Processing Software].

(2) At this stage, the positions of individual sensors will be calculated from the precisely measured sensor-GPS antennae offsets and the instantaneous track direction of the array. These individual sensor track positions will be referenced as sublines 1 to 4. In distance mode, this stage is automated [G-TEK's preprocessing software].

(3) The GPS, rover magnetometer, and base magnetometer data will be merged on the 10-Hz time-base during post-processing, and corrections will then be applied [GEOSOFT]. In distance mode, just the magnetometer and base station data are merged, positioned, and corrected.

(4) The magnetometer data will be automatically and manually scanned for the removal of invalid data [GEOSOFT].

(5) At this stage, the raw data will be exported to GEOSOFT American Standard Code for Information Interchange (ASCII) XYZ format (with line reference headers and column labels), in compliance with the Raw Data Submittal guidelines on the Standardized UXO Technology Demonstration Site - Submission for Scoring Web site. The data will then be written to compact disc (CD) for submission [GEOSOFT].

(6) The data will be resampled to a distance base of no greater than 0.05-meter to facilitate band-pass filtering and reduce the effects from wavelengths determined to be inconsistent with the target anomalies (e.g., deep geology, system noise) [G-TEK's GEOSOFT GXs].

(7) The data will be graded to a square mesh no greater than 0.05 meter, using minimum curvature grading and the GEOSOFT FLOAT grid format [GEOSOFT].

(8) The graded data will be loaded into the viewing and interpretation software for semi-automated interpretation. This process involves the automatic selection of associated maximums and minimums whose amplitudes exceed the interpretation threshold; these are manually checked. The selected anomalies are then inverted against a list of target items to find the best fit and the degree of magnetic remanence required. Use will be made of the ground-truth data from the Calibration Lane to fine-tune the discrimination parameters. This will provide the basis for the discrimination classification and prioritization in the submittal [G-TEK's MagSys software].

(9) The information from the selected anomalies (Processed Data) will be imported into a Microsoft (MS)-Excel spreadsheet for formatting for presentation as a dig sheet based on the template Attachment C, DID OE-005-05.01 and written to CD for submittal [G-TEK's EOD Reporter MS Excel macro].

(10) The dig sheet data (Processed Data) will also be reformatted to comply with the Processed Data Submittal guidelines on the Standardized UXO Technology Demonstration Site - Submission for Scoring Web site. The data will then be written to CD for submission [MS EXCEL].

(11) The color contour, processed magnetic grid-image, with selected anomalies marked, will be presented based on the map template Attachment D, DID OE-005-05.01 also on CD [GEOSOFT].

c. Discrimination.

The discrimination will be performed using G-TEK's MagSys display, interpretation, and discrimination software. This tool enables the selected anomalies to be inverted to a series of spheroids representing UXO and cluster items known to exist at this site. A user-selectable amount of remanence will be permitted into the inversion parameters. The dipole moment, direction, and strength will also be listed for each item. These discrimination parameters will then be fine-tuned using the Calibration Lane data.

2.1.4 Data Submission Format

Data were submitted for scoring in accordance with data submission protocols outlined in the Standardized UXO Technology Demonstration Site Handbook (app E, ref 1). These submitted data are not included in this report in order to protect ground truth information.

2.1.5 Demonstrator Quality Assurance (QA) and Quality Control (QC) (provided by demonstrator)

Quality Control. G-TEK will perform QC steps and tests using the DID OE_005.05.02 and the following QC conditions:

Test Description	Power On	Day Start	Day Start/End	First Day	Repeat Last 2 Grid Lines
Equipment warmup	5-min.				
Record sensor offsets		X			
Personnel test		X			
Vibration test		X			
Static and spike test			3 min/1 min/3 min		
Six line test				X	
Repeat line test					X
Visit survey point			X		

Equipment/Electronics Warmup for 5 Minutes: Allows for thermal stabilization of electronics.

Record Relative Sensor Position (1- cm Accuracy): Documents relative navigation and sensor offsets, detector separation, and detector heights above the ground surface.

Personnel Test (10 emu at 10 cm from the Sensors): Ensures that survey personnel have removed all potential metallic interference sources from their bodies.

Shake Test (<10 emu at 10 cm from the Sensor): Identifies and replaces shorting cables and broken pin-outs on connectors. With the instrument held in a static position while collecting data, cables are shaken to test for shorts and broken pin-outs. Repaired or replaced cables are rigorously retested before use.

Static Background and Static Standard Response (Spike) Test (10 emu): Quantifies instrument background readings and electronic drift, locates potential interference spikes, and determines impulse response and repeatability of the instrument to a standard test item. Reviews in real-time.

Six Line Test (Repeatability of Response Amplitude +/-20 percent, Positional Accuracy +/-20 cm): Documents latency, heading effects, repeatability of response amplitude, and positional accuracy. The test line will be well marked to facilitate data collection over the exact same line each time the test is performed. Background response over the test line is established in lines 1 and 2. A standard test item, such as a steel trailer hitch ball, will be used for lines 3 through 6.

Visit Survey Point (±25 mm): Checks that GPS base location and transformations are correct.
Repeat Last Two Lines of Each Grid (Repeatability of Response Amplitude +/-20 percent, Positional Accuracy +/-20 cm): Determines positional and geophysical data repeatability.

TM-4 MAG Calibration (>250 emu): Using a calibration device known as an EMUlator (developed by G-TEK to establish the integrity of the TM-4 MAG), the EMUlator is placed so that it touches the rim of the sensor coil and data are recorded for a period of 60 seconds. The EMUlator delivers a controlled response to the excitation transmitted by the TM-4 MAG.

Sensor Elevation: The TM- 4 MAG will be operated at a low but uniform elevation. To help the operator achieve the elevation, a piece of nonconductive tape will be attached to the back of the coil such that it hangs 10 cm. The operator then maintains the end of the tape just touching the ground (or where he judges the ground to be below the grass cover). Higher elevations due to vegetation will be noted.

Data Processing: The data processing and interpretations will be checked by a second geophysicist, and all intermediate processing stages of the data will be retained in meaningfully named columns within GEOSOFT for this purpose. All data will be backed up daily.

Quality Assurance (QA). The data collected during the pre-survey QC checks will be processed, documented, and checked by the data processing geophysicist to ensure that the entire system will provide the quality to achieve the desired outcome of detecting and correctly discriminating the UXO items down to their specified depths, as determined by the site conditions.

- The RTK DGPSs have a quoted accuracy of 2.0 cm + 0.1 mm/(km to the base station) Central Error Probability (CEP) in dynamic mode. In practice, however, assuming a consistent differential correction of 1 per second and a baseline of less than 2 km, the worst-case absolute accuracy will be ±5.0 cm with a typical accuracy of ±2.5 cm. Synchronization errors between the electromagnetic detector and the GPS will be reduced by calibration down to the resolution of the sampling rate of 0.03 second. In sloping terrain, an additional error will occur when the GPS antennae pole varies from the vertical.

- In forested areas, an electronic cotton odometer system will be used to track the positions of the sensors along the line. This system has an inherent along-line accuracy of <1 percent and a resolution of 5 cm. However, when the start and end positions are known, this error is reduced to <0.2 percent of the distance between known points. In this case, we propose to have control lines at no greater than 25-meter intervals, providing an accuracy of ±5 cm.

Estimated Accuracy of the Navigation System: The primary navigation method will be the use of accurately placed sighters along the control lines. The operators must then keep at least two sighters in line with the center point of the sensor array. This navigation technique will be used with the tracking systems of both the cotton and the GPS positions. The advantage of this mehtod is its simplicity and applicability to difficult situations. Its accuracy depends on the accuracy of the pegged grid and the diligence of the operators. The anticipated typical across-line error is ± 10 cm. The effective swath width of the 2-sensor array will be 1.2 meters. The nominal lane space of 1.0 meter will allow for cross-line navigation variations.

QA of Positioning: The GEOSOFT Department of Defense (DOD) UXO QA system will be used to report on Line Coverage Comparisons. This report will allow the quantification of the data positioning on a line basis. Lines that fail will trigger Re-Do orders to the field crew leaders.

QA of Sensor Data Quality: The quality of each subline of data will be quantified as the largest distance with consecutive invalid sensor data. If a subline fails the criteria, a Re-Do order will be triggered. The magnetometer base station will be subjected to similar quality quantification and recording processes.

QA Based on a Two-Traverse Resurvey: The sensor data and interpretation will be compared with the original, and whole-system repeatability will be reported for QA.

QA of Data Processing: During data processing, the dates and times of the various data streams will be automatically correlated by the software. A second QC geophysicist will check the quality of the raw data, selected processing parameters, interpretation parameters, and final grid data. The data will then provide QA of the interpretation by checking each grid of the data for missed anomalies. The QC geophysicist can then add but not delete more anomalies. The QC geophysicist will then repeat the discrimination process on 10 percent of the anomalies and compare the results. The process will ensure the quality of the final prioritized dig sheet results. The results will allow the generation of quantified, ensured depth of detection versus caliber graph.

2.1.6 Additional Records

The following record(s) by this vendor can be accessed via the Internet as MicroSoft Word documents at www.uxotestsites.org.

2.2 YPG SITE INFORMATION

2.2.1 Location

YPG is located adjacent to the Colorado River in the Sonoran Desert. The UXO Standardized Test Site is located south of Pole Line Road and east of the Countermine Testing and Training Range. The Open Field range, Calibration Grid, Blind Grid, Mogul area, and Desert Extreme area comprise the 350- by 500-meter general test site area. The open field site is the largest of the test sites and measures approximately 200 by 350 meters. To the east of the open field range are the calibration and blind test grids that measure 30 by 40 meters and 40 by 40 meters, respectively. South of the Open Field is the 135- by 80-meter Mogul area consisting of a sequence of man-made depressions. The Desert Extreme area is located southeast of the open field site and has dimensions of 50 by 100 meters. The Desert Extreme area, covered with desert-type vegetation, is used to test the performance of different sensor platforms in a more severe desert condition/environment.

2.2.2 Soil Type

Soil samples were collected at the YPG UXO Standardized Test Site by ERDC, to characterize the shallow subsurface (< 3 m). Both surface grab samples and continuous soil borings were acquired. The soils were subjected to several laboratory analyses, including sieve/hydrometer, water content, magnetic susceptibility, dielectric permittivity, X-ray diffraction, and visual description.

Two soil complexes are present within the site, Riverbend-Carrizo and Cristobal-Gunsight. The Riverbend-Carrizo complex is composed of mixed-stream alluvium, whereas the Cristobal-Gunsight complex is derived from fan alluvium. The Cristobal-Gunsight complex covers the majority of the site. Most of the soil samples were classified as either a sandy loam or loamy sand, with most samples containing gravel-size particles. All samples had a measured water content of less than 7 percent, except for two that contained 11-percent moisture. The majority of soil samples had water content between 1 and 2 percent. Samples containing more than 3 percent were generally deeper than 1 meter.

An X-ray diffraction analysis on four soil samples indicated a basic mineralogy of quartz, calcite, mica, feldspar, magnetite, and some clay. The presence of magnetite imparted a moderate magnetic susceptibility, with volume susceptibilities generally greater than 100 by 10-5 SI.

For more details concerning the soil properties at the YPG test site, go to www.uxotestsites.org on the web to view the entire soils description report (ref 2).

2.2.3 Test Areas

A description of the test site areas at YPG is included in Table 2.

TABLE 2. TEST SITE AREAS

Area	Description
Calibration Grid	Contains the 15 standard ordnance items buried in six positions at various angles and depths to allow demonstrator equipment calibration.
Blind Grid	Contains 400 grid cells in a 0.16-hectare (0.39-acre) site. The center of each grid cell contains ordnance, clutter, or nothing.

SECTION 3. FIELD DATA

3.1 DATE OF FIELD ACTIVITIES: 28 October and 6 November 2003

3.2 AREAS TESTED/NUMBER OF HOURS

Areas tested and total number of hours operated at each site are summarized in Table 3.

TABLE 3. AREAS TESTED AND NUMBER OF HOURS

Area	Number of Hours
Calibration Lanes	0.90
Blind Grid	0.77

3.3 TEST CONDITIONS

3.3.1 Weather Conditions

A YPG weather station located approximately 1-mile west of the test site was used to record average temperature and precipitation on a half-hour basis for each day of operation. The temperatures listed in Table 4 represent the average temperature during field operations from 0700 to 1700 hours, while precipitation data represent a daily total amount of rainfall. Hourly weather logs used to generate this summary are provided in Appendix B.

TABLE 4. TEMPERATURE/PRECIPITATION DATA SUMMARY

Date, 2003	Average Temperature, ^{o}F	Total Daily Precipitation, in.
28 October	73.65	0.00
6 November	62.73	0.00

3.3.2 Field Conditions

The field conditions remained dry throughout the demonstration.

3.3.3 Soil Moisture

Three soil probes were placed at various locations within the site to capture soil moisture data: Calibration, Mogul, and Desert Extreme areas. Measurements were collected in percent moisture and were taken twice daily (morning and afternoon) from five different soil depths (0 to 6 in., 6 to 12 in., 12 to 24 in., 24 to 36 in., and 36 to 48 in.) from each probe. Soil moisture logs are included in Appendix C.

3.4 FIELD ACTIVITIES

3.4.1 Setup/Mobilization

These activities included initial mobilization and daily equipment preparation and breakdown. The initial setup of equipment took 2 hours and 10 minutes on 28 October 2003. The total survey was conducted within 1-day, and G-TEK went to the Open Field for the remainder of the day. Therefore, the time for daily setup or breakdown was not accounted for.

3.4.2 Calibration

G-TEK spent 54 minutes in the calibration lanes, 35 minutes of which was spent collecting data.

3.4.3 Downtime Occasions

Occasions of downtime are grouped into five categories: equipment/data checks or equipment maintenance, equipment failure and repair, weather, Demonstration Site issues, or breaks/lunch. All downtime is included for the purposes of calculating labor costs (section 5) except for downtime due to Demonstration Site issues. Demonstration Site issues, while noted in the Daily Log, are considered non-chargeable downtime for the purposes of calculating labor costs and are not discussed. Breaks and lunches are included in this section and billed to the total Site Survey area.

3.4.3.1 Equipment/data checks, maintenance. G-TEK performed no equipment checks or maintenance while surveying the Blind Grid. A total of 10 minutes was spent on a break on 28 October 2003.

3.4.3.2 Equipment failure or repair. G-TEK experienced no equipment problems while surveying the Calibration Lanes or Blind Grid.

3.4.3.3 Weather. Overall weather conditions did not interfere with the demonstration. Conditions remained dry and pleasant.

3.4.4 Data Collection

G-TEK spent a total time of 46 minutes in the Blind Grid area, 36 minutes of which was spent collecting data.

3.4.5 Demobilization

G-TEK conducted a demonstration of the entire site with the TM 4 MAG system. Therefore, demobilization did not occur until 6 November 2003, when the crew spent 2 hours and 40 minutes breaking down and packing up their equipment.

3.5 PROCESSING TIME

G-TEK submitted the raw data from the demonstration activities on the last day of the demonstration, as required. The scoring submittal data was also provided within the required 30-day time frame.

3.6 DEMONSTRATOR'S FIELD SURVEYING METHOD

G-TEK began surveying in the northwest corner of both the calibration lanes and Blind Grid. Both surveys were conducted in a north/south direction.

3.7 SUMMARY OF DAILY LOGS

Daily logs capture all field activities during this demonstration and are located in Appendix D. Activities pertinent to this specific demonstration are indicated in highlighted text.

SECTION 4. TECHNICAL PERFORMANCE RESULTS

4.1 ROC CURVES USING ALL ORDNANCE CATEGORIES

Figure 2 shows the probability of detection for the response stage (P_d^{res}) and the discrimination stage (P_d^{disc}) versus their respective probability of false positive. Figure 3 shows both probabilities plotted against their respective probability of background alarm. Both figures use horizontal lines to illustrate the performance of the demonstrator at two demonstrator-specified points: at the system noise level for the response stage, representing the point below which targets are not considered detectable, and at the demonstrator's recommended threshold level for the discrimination stage, defining the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

The overall ground truth is composed of ferrous and non-ferrous anomalies. Due to limitations of the magnetometer, the non-ferrous items cannot be detected. Therefore, the ROC curves presented in this section are based on the subset of the ground truth that is solely made up of ferrous anomalies.

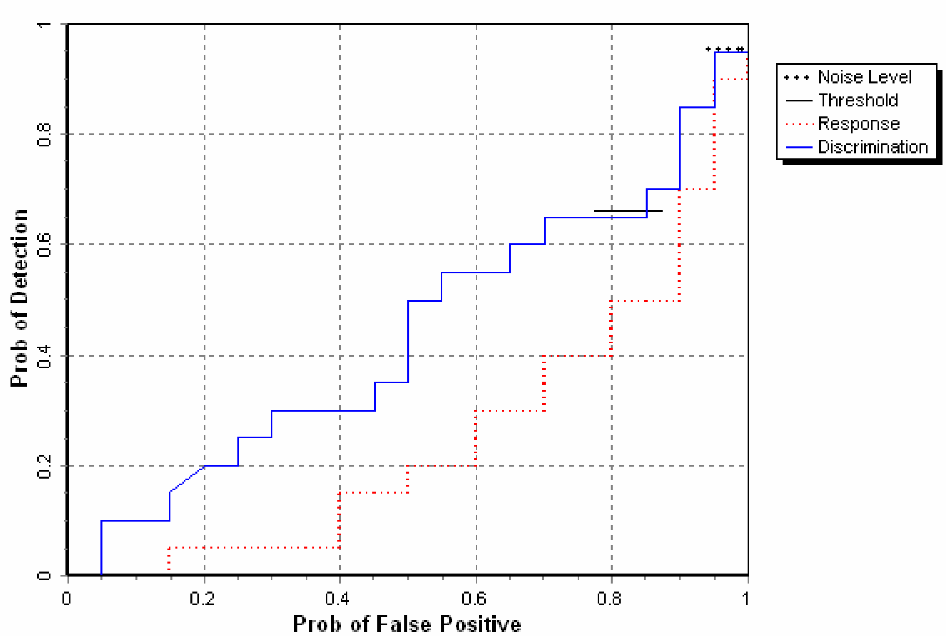

Figure 2. TM-4 MAG array blind grid probability of detection for response and discrimination stages versus the respective probability of false positive over all ordnance categories combined.

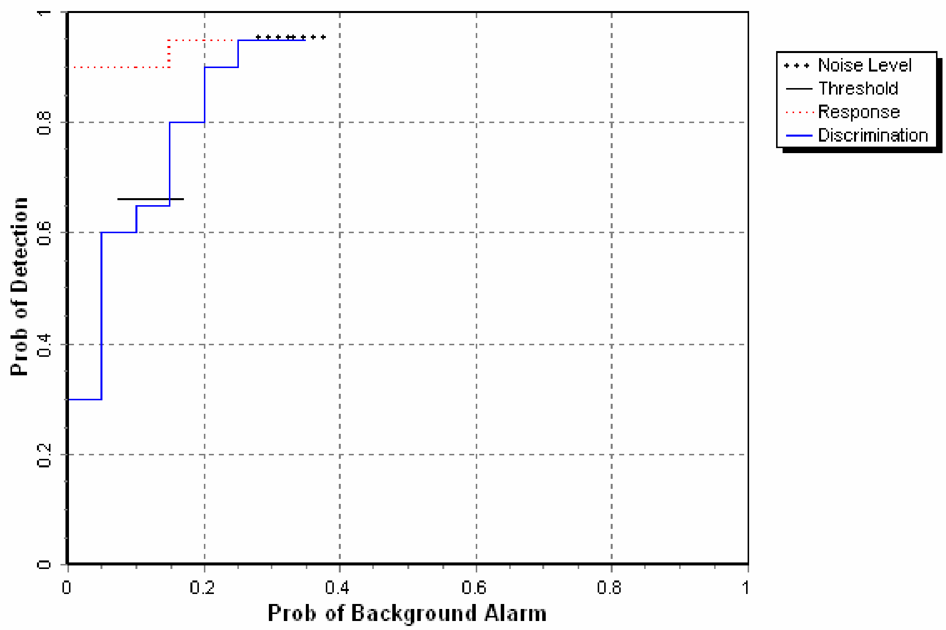

Figure 3. TM-4 MAG array blind grid probability of detection for response and discrimination stages versus the respective probability of background alarm over all ordnance categories combined.

4.2 ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 4 shows the probability of detection for the response stage (P_d^{res}) and the discrimination stage (P_d^{disc}) versus their respective probability of false positive when only targets larger than 20 mm are scored. Figure 5 shows both probabilities plotted against their respective probability of background alarm. Both figures use horizontal lines to illustrate the performance of the demonstrator at two demonstrator-specified points: at the system noise level for the response stage, representing the point below which targets are not considered detectable, and at the demonstrator's recommended threshold level for the discrimination stage, defining the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

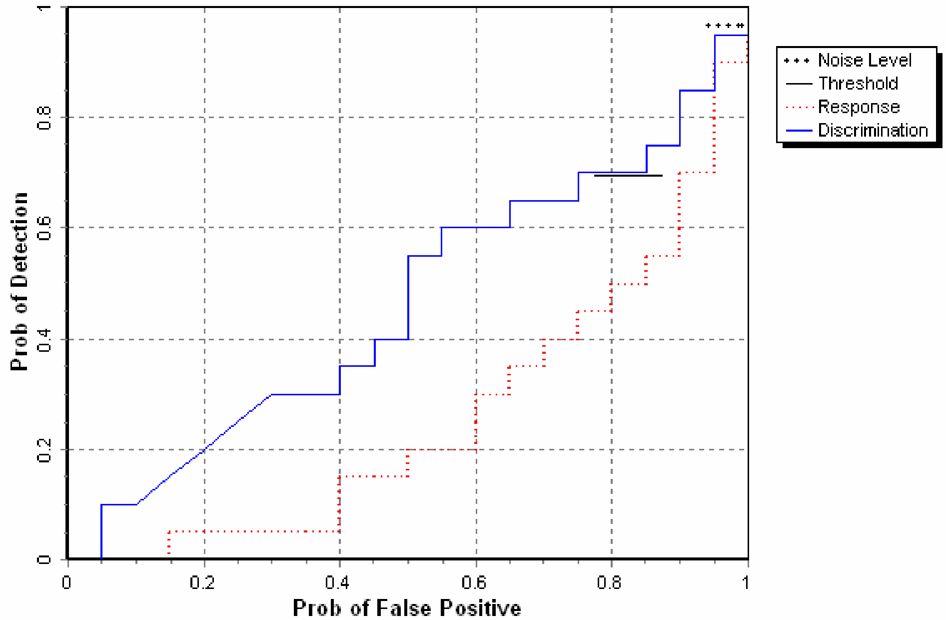

Figure 4. TM-4 MAG array blind grid probability of detection for response and discrimination stages versus the respective probability of false positive for all ordnance larger than 20 mm.

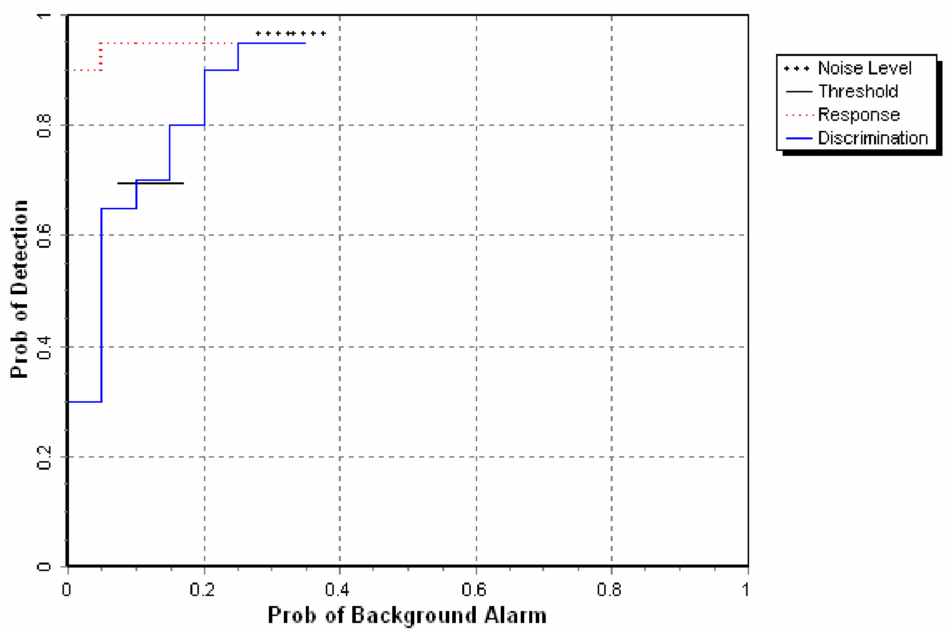

Figure 5. TM-4 MAG array blind grid probability of detection for response and discrimination stages versus the respective probabilities of background alarm for all ordnance larger than 20 mm.

4.3 PERFORMANCE SUMMARIES

Results for the Blind Grid test, broken out by size, depth and nonstandard ordnance, are presented in Table 5a and 5b (for cost results, see section 5). Results by size and depth include both standard and nonstandard ordnance. The results by size show how well the demonstrator did at detecting/discriminating ordnance of a certain caliber range (see app A for size definitions). The results are relative to the number of ordnances emplaced.

The RESPONSE STAGE results are derived from the list of anomalies above the demonstrator-provided noise level. The results for the DISCRIMINATION STAGE are derived from the demonstrator's recommended threshold for optimizing UXO field cleanup by minimizing false digs and maximizing ordnance recovery. The lower 90-percent confidence limit on probability of detection and probability of false positive was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results in Table 5a and 5b have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

The overall ground truth is composed of ferrous and non-ferrous anomalies. Due to limitations of the magnetometer, the non-ferrous items cannot be detected. Therefore, the summary presented in Table 5a exhibits results based on the subset of the ground truth that is solely the ferrous anomalies. Table 5b exhibits results based on the full ground truth. All other tables presented in this section are based on scoring against the ferrous only ground truth. The response stage noise level and recommended discrimination stage threshold values are provided by the demonstrator.

TABLE 5a. SUMMARY OF BLIND GRID RESULTS (FERROUS ONLY)

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	0.95	1.00	0.90	0.95	0.95	0.95	0.95	1.00	0.70
P_d Low 90% Conf	0.90	0.94	0.77	0.87	0.84	0.75	0.90	0.90	0.40
P_d Upper 90% Conf	0.98	1.00	0.96	1.00	1.00	0.99	1.00	1.00	0.92
P_{fp}	1.00	-	-	-	-	-	1.00	1.00	0.00
P_{fp} Low 90% Conf	0.97	-	-	-	-	-	0.96	0.92	-
P_d Upper 90% Conf	1.00	-	-	-	-	-	1.00	1.00	-
P_{ba}	0.35	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.65	0.75	0.55	0.60	0.70	0.70	0.70	0.75	0.30
P_d Low 90% Conf	0.58	0.62	0.42	0.47	0.54	0.51	0.58	0.57	0.08
P_d Upper 90% Conf	0.74	0.83	0.69	0.73	0.82	0.87	0.80	0.85	0.60
P_{fp}	0.80	-	-	-	-	-	0.85	0.80	0.00
P_{fp} Low 90% Conf	0.77	-	-	-	-	-	0.77	0.65	-
P_d Upper 90% Conf	0.87	-	-	-	-	-	0.89	0.88	-
P_{ba}	0.10	-	-	-	-	-	-	-	-

Response Stage Noise Level: 1.20.
Recommended Discrimination Stage Threshold: 0.50.

TABLE 5b. SUMMARY OF BLIND GRID RESULTS (FULL GROUND TRUTH)

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	0.90	0.90	0.85	0.85	0.95	0.95	0.90	0.95	0.70
P_d Low 90% Conf	0.83	0.83	0.74	0.73	0.84	0.75	0.79	0.85	0.40
P_d Upper 90% Conf	0.94	0.96	0.94	0.91	1.00	0.99	0.94	1.00	0.92
P_{fp}	1.00	-	-	-	-	-	1.00	1.00	0.00
P_{fp} Low 90% Conf	0.97	-	-	-	-	-	0.96	0.92	-
P_d Upper 90% Conf	1.00	-	-	-	-	-	1.00	1.00	-
P_{ba}	0.35	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.60	0.65	0.50	0.50	0.70	0.70	0.60	0.70	0.30
P_d Low 90% Conf	0.51	0.54	0.38	0.37	0.54	0.51	0.47	0.56	0.08
P_d Upper 90% Conf	0.67	0.74	0.65	0.60	0.82	0.87	0.68	0.83	0.60
P_{fp}	0.80	-	-	-	-	-	0.85	0.80	0.00
P_{fp} Low 90% Conf	0.77	-	-	-	-	-	0.77	0.65	-
P_d Upper 90% Conf	0.87	-	-	-	-	-	0.89	0.88	-
P_{ba}	0.10	-	-	-	-	-	-	-	-

Response Stage Noise Level: 0.62.
Recommended Discrimination Stage Threshold 0.50.

4.4 EFFICIENCY, REJECTION RATES, AND TYPE CLASSIFICATION

Efficiency and rejection rates are calculated to quantify the discrimination ability at specific points of interest on the ROC curve: (1) at the point where no decrease in P_d is suffered (i.e., the efficiency is by definition equal to one) and (2) at the operator selected threshold. These values are reported in Table 6.

TABLE 6. EFFICIENCY AND REJECTION RATES

	Efficiency (E)	False Positive Rejection Rate	Background Alarm Rejection Rate
At Operating Point	0.67	0.17	0.63
With No Loss of P_d	1.00	0.01	0.03

At the demonstrator’s recommended setting, the ordnance items that were detected and correctly discriminated were further scored on whether their correct type could be identified (Table 8). Correct type examples include “20-mm projectile, 105-mm HEAT Projectile, and 2.75-inch Rocket”. A list of the standard type declaration required for each ordnance item was provided to demonstrators prior to testing. For example, the standard type for the three example items are 20mmP, 105H, and 2.75in, respectively.

TABLE 7. CORRECT TYPE CLASSIFICATION OF TARGETS CORRECTLY DISCRIMINATED AS UXO

Size	Percentage Correct
Small	11.1
Medium	25.0
Large	60.0
Overall	27.3

4.5 LOCATION ACCURACY

The mean location error and standard deviations appear in Table 8. These calculations are based on average missed depth for ordnance correctly identified in the discrimination stage. Depths are measured from the closest point of the ordnance to the surface. For the Blind Grid, only depth errors are calculated, since (X, Y) positions are known to be the centers of each grid square.

TABLE 8. MEAN LOCATION ERROR AND STANDARD DEVIATION (M)

	Mean	Standard Deviation
Depth	-0.07	0.21

SECTION 5. ON-SITE LABOR COSTS

A standardized estimate for labor costs associated with this effort was calculated as follows: the first person at the test site was designated "supervisor", the second person was designated "data analyst", and the third and following personnel were considered "field support". Standardized hourly labor rates were charged by title: supervisor at $95.00/hour, data analyst at $57.00/hour, and field support at $28.50/hour.

Government representatives monitored on-site activity. All on-site activities were grouped into one of ten categories: initial setup/mobilization, daily setup/stop, calibration, collecting data, downtime due to break/lunch, downtime due to equipment failure, downtime due to equipment/data checks or maintenance, downtime due to weather, downtime due to demonstration site issue, or demobilization. See Appendix D for the daily activity log. See section 3.4 for a summary of field activities.

The standardized cost estimate associated with the labor needed to perform the field activities is presented in Table 9. Note that calibration time includes time spent in the Calibration Lanes as well as field calibrations. "Site survey time" includes daily setup/stop time, collecting data, breaks/lunch, downtime due to equipment/data checks or maintenance, downtime due to failure, and downtime due to weather.

TABLE 9. ON-SITE LABOR COSTS

	No. People	Hourly Wage	Hours	Cost
INITIAL SETUP				
Supervisor	1	$95.00	2.17	$206.15
Data Analyst	1	57.00	2.17	123.69
Field Support	1	28.50	2.17	61.85
SubTotal				**$391.69**
CALIBRATION				
Supervisor	1	$95.00	0.90	$85.50
Data Analyst	1	57.00	0.90	51.30
Field Support	1	28.50	0.90	25.65
SubTotal				**$162.45**
SITE SURVEY				
Supervisor	1	$95.00	0.77	$73.15
Data Analyst	1	57.00	0.77	43.89
Field Support	1	28.50	0.77	21.95
SubTotal				**$138.99**

See notes at end of table.

TABLE 9 (CONT'D)

	No. People	Hourly Wage	Hours	Cost
DEMOBILIZATION				
Supervisor	1	$95.00	2.67	$253.65
Data Analyst	1	57.00	2.67	152.19
Field Support	0	28.50	2.67	0.00
Subtotal				**$405.84**
Total				**$1,098.97**

Notes: Calibration time includes time spent in the Calibration Lanes as well as calibration before each data run.

Site Survey time includes daily setup/stop time, collecting data, breaks/lunch, downtime due to system maintenance, failure, and weather.

SECTION 6. COMPARISON OF RESULTS TO DATE

No comparisons to date.

SECTION 7. APPENDIXES

APPENDIX A. TERMS AND DEFINITIONS

GENERAL DEFINITIONS

Anomaly: Location of a system response deemed to warrant further investigation by the demonstrator for consideration as an emplaced ordnance item.

Detection: An anomaly location that is within R_{halo} of an emplaced ordnance item.

Emplaced Ordnance: An ordnance item buried by the government at a specified location in the test site.

Emplaced Clutter: A clutter item (i.e., non-ordnance item) buried by the government at a specified location in the test site.

R_{halo}: A pre-determined radius about the periphery of an emplaced item (clutter or ordnance) within which a location identified by the demonstrator as being of interest is considered to be a response from that item. If multiple declarations lie within R_{halo} of any item (clutter or ordnance), the declaration with the highest signal output within the R_{halo} will be utilized. For the purpose of this program, a circular halo 0.5 meters in radius will be placed around the center of the object for all clutter and ordnance items less than 0.6 meters in length. When ordnance items are longer than 0.6 meters, the halo becomes an ellipse where the minor axis remains 1 meter and the major axis is equal to the length of the ordnance plus 1 meter.

Small Ordnance: Caliber of ordnance less than or equal to 40-mm (includes 20-mm projectile, 40-mm projectile, submunitions BLU-26, BLU-63, and M42).

Medium Ordnance: Caliber of ordnance greater than 40-mm and less than or equal to 81 mm (includes 57-mm projectile, 60-mm mortar, 2.75 in. Rocket, MK118 Rockeye, 81-mm mortar).

Large Ordnance: Caliber of ordnance greater than 81 mm (includes 105-mm HEAT, 105-mm projectile, 155-mm projectile, 500-pound bomb).

Shallow: Items buried less than 0.3 meter below ground surface.

Medium: Items buried greater than or equal to 0.3 meter and less than 1 meter below ground surface.

Deep: Items buried greater than or equal to 1 meter below ground surface.

Response Stage Noise Level: The level that represents the point below which anomalies are not considered detectable. Demonstrators are required to provide the recommended noise level for the Blind Grid test area.

Discrimination Stage Threshold: The demonstrator selected threshold level that they believe provides optimum performance of the system by retaining all detectable ordnance and rejecting the maximum amount of clutter. This level defines the subset of anomalies the demonstrator would recommend digging based on discrimination.

Binomially Distributed Random Variable: A random variable of the type which has only two possible outcomes, say success and failure, is repeated for n independent trials with the probability p of success and the probability 1-p of failure being the same for each trial. The number of successes x observed in the n trials is an estimate of p and is considered to be a binomially distributed random variable.

RESPONSE AND DISCRIMINATION STAGE DATA

The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}) and those that do not correspond to any known item, termed background alarms.

The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the RESPONSE STAGE, the demonstrator provides the scoring committee with the location and signal strength of all anomalies that the demonstrator has deemed sufficient to warrant further investigation and/or processing as potential emplaced ordnance items. This list is generated with minimal processing (e.g., this list will include all signals above the system noise threshold). As such, it represents the most inclusive list of anomalies.

The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such, and to reject clutter. For the same locations as in the RESPONSE STAGE anomaly list, the DISCRIMINATION STAGE list contains the output of the algorithms applied in the discrimination-stage processing. This list is prioritized based on the demonstrator's determination that an anomaly location is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For electronic signal processing, priority ranking is based on algorithm output. For other systems, priority ranking is based on human judgment. The demonstrator also selects the threshold that the demonstrator believes will provide "optimum" system performance, (i.e., that retains all the detected ordnance and rejects the maximum amount of clutter).

Note: The two lists provided by the demonstrator contain identical numbers of potential target locations. They differ only in the priority ranking of the declarations.

RESPONSE STAGE DEFINITIONS

Response Stage Probability of Detection (P_d^{res}): P_d^{res} = (No. of response-stage detections)/(No. of emplaced ordnance in the test site).

Response Stage False Positive (fp^{res}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Response Stage Probability of False Positive (P_{fp}^{res}): P_{fp}^{res} = (No. of response-stage false positives)/(No. of emplaced clutter items).

Response Stage Background Alarm (ba^{res}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Response Stage Probability of Background Alarm (P_{ba}^{res}): Blind Grid only: P_{ba}^{res} = (No. of response-stage background alarms)/(No. of empty grid locations).

Response Stage Background Alarm Rate (BAR^{res}): Open Field only: BAR^{res} = (No. of response-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{res}, P_{fp}^{res}, P_{ba}^{res}, and BAR^{res} are functions of t^{res}, the threshold applied to the response-stage signal strength. These quantities can therefore be written as $P_d^{res}(t^{res})$, $P_{fp}^{res}(t^{res})$, $P_{ba}^{res}(t^{res})$, and $BAR^{res}(t^{res})$.

DISCRIMINATION STAGE DEFINITIONS

Discrimination: The application of a signal processing algorithm or human judgment to response-stage data that discriminates ordnance from clutter. Discrimination should identify anomalies that the demonstrator has high confidence correspond to ordnance, as well as those that the demonstrator has high confidence correspond to non-ordnance or background returns. The former should be ranked with highest priority and the latter with lowest.

Discrimination Stage Probability of Detection (P_d^{disc}): P_d^{disc} = (No. of discrimination-stage detections)/(No. of emplaced ordnance in the test site).

Discrimination Stage False Positive (fp^{disc}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Discrimination Stage Probability of False Positive (P_{fp}^{disc}): P_{fp}^{disc} = (No. of discrimination stage false positives)/(No. of emplaced clutter items).

Discrimination Stage Background Alarm (ba^{disc}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Discrimination Stage Probability of Background Alarm (P_{ba}^{disc}): P_{ba}^{disc} = (No. of discrimination-stage background alarms)/(No. of empty grid locations).

Discrimination Stage Background Alarm Rate (BAR^{disc}): BAR^{disc} = (No. of discrimination-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{disc}, P_{fp}^{disc}, P_{ba}^{disc}, and BAR^{disc} are functions of t^{disc}, the threshold applied to the discrimination-stage signal strength. These quantities can therefore be written as $P_d^{disc}(t^{disc})$, $P_{fp}^{disc}(t^{disc})$, $P_{ba}^{disc}(t^{disc})$, and $BAR^{disc}(t^{disc})$.

RECEIVER-OPERATING CHARACERISTIC (ROC) CURVES

ROC curves at both the response and discrimination stages can be constructed based on the above definitions. The ROC curves plot the relationship between P_d versus P_{fp} and P_d versus BAR or P_{ba} as the threshold applied to the signal strength is varied from its minimum (t_{min}) to its maximum (t_{max}) value.[1] Figure A-1 shows how P_d versus P_{fp} and P_d versus BAR are combined into ROC curves. Note that the "res" and "disc" superscripts have been suppressed from all the variables for clarity.

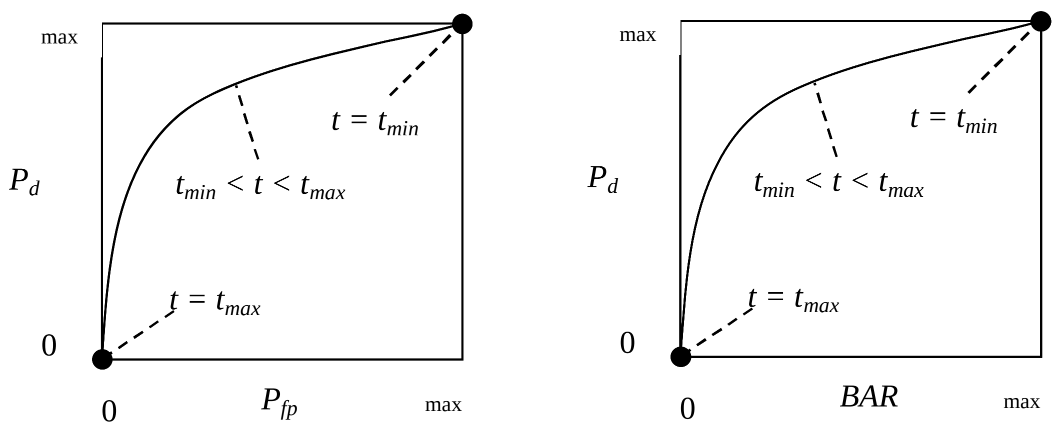

Figure A-1. ROC curves for open field-testing. Each curve applies to both the response and discrimination stages.

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[1]Strictly speaking, ROC curves plot the P_d versus P_{ba} over a pre-determined and fixed number of detection opportunities (some of the opportunities are located over ordnance and others are located over clutter or blank spots). In an open field scenario, each system suppresses its signal strength reports until some bare-minimum signal response is received by the system. Consequently, the open field ROC curves do not have information from low signal-output locations, and, furthermore, different contractors report their signals over a different set of locations on the ground. These ROC curves are thus not true to the strict definition of ROC curves as defined in textbooks on detection theory. Note, however, that the ROC curves obtained in the Blind Grid test sites are true ROC curves.

METRICS TO CHARACTERIZE THE DISCRIMINATION STAGE

The demonstrator is also scored on efficiency and rejection ratio, which measure the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. The efficiency measures the amount of detected ordnance retained by the discrimination, while the rejection ratio measures the fraction of false alarms rejected. Both measures are defined relative to the entire response list, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

Efficiency (E): $E = P_d^{disc}(t^{disc})/P_d^{res}(t_{min}^{res})$; Measures (at a threshold of interest), the degree to which the maximum theoretical detection performance of the sensor system (as determined by the response stage t_{min}) is preserved after application of discrimination techniques. Efficiency is a number between 0 and 1. An efficiency of 1 implies that all of the ordnance initially detected in the response stage was retained at the specified threshold in the discrimination stage, t^{disc}.

False Positive Rejection Rate (R_{fp}): $R_{fp} = 1 - [P_{fp}^{disc}(t^{disc})/P_{fp}^{res}(t_{min}^{res})]$; Measures (at a threshold of interest), the degree to which the sensor system's false positive performance is improved over the maximum false positive performance (as determined by the response stage t_{min}). The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all emplaced clutter initially detected in the response stage were correctly rejected at the specified threshold in the discrimination stage.

Background Alarm Rejection Rate (R_{ba}):

Blind Grid: $R_{ba} = 1 - [P_{ba}^{disc}(t^{disc})/P_{ba}^{res}(t_{min}^{res})]$.
Open Field: $R_{ba} = 1 - [BAR^{disc}(t^{disc})/BAR^{res}(t_{min}^{res})]$).

Measures the degree to which the discrimination stage correctly rejects background alarms initially detected in the response stage. The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all background alarms initially detected in the response stage were rejected at the specified threshold in the discrimination stage.

CHI-SQUARE COMPARISON EXPLANATION:

The Chi-square test for differences in probabilities (or 2 x 2 contingency table) is used to analyze two samples drawn from two different populations to see if both populations have the same or different proportions of elements in a certain category. More specifically, two random samples are drawn, one from each population, to test the null hypothesis that the probability of event A (some specified event) is the same for both populations (ref 3).

A 2 x 2 contingency table is used in the Standardized UXO Technology Demonstration Site Program to determine if there is reason to believe that the proportion of ordnance correctly detected/discriminated by demonstrator X's system is significantly degraded by the more challenging terrain feature introduced. The test statistic of the 2 x 2 contingency table is the

Chi-square distribution with one degree of freedom. Since an association between the more challenging terrain feature and relatively degraded performance is sought, a one-sided test is performed. A significance level of 0.05 is chosen which sets a critical decision limit of 2.71 from the Chi-square distribution with one degree of freedom. It is a critical decision limit because if the test statistic calculated from the data exceeds this value, the two proportions tested will be considered significantly different. If the test statistic calculated from the data is less than this value, the two proportions tested will be considered not significantly different.

An exception must be applied when either a 0 or 100 percent success rate occurs in the sample data. The Chi-square test cannot be used in these instances. Instead, Fischer's test is used and the critical decision limit for one-sided tests is the chosen significance level, which in this case is 0.05. With Fischer's test, if the test statistic is less than the critical value, the proportions are considered to be significantly different.

Standardized UXO Technology Demonstration Site examples, where blind grid results are compared to those from the open field and open field results are compared to those from one of the scenarios, follow. It should be noted that a significant result does not prove a cause and effect relationship exists between the two populations of interest; however, it does serve as a tool to indicate that one data set has experienced a degradation in system performance at a large enough level than can be accounted for merely by chance or random variation. Note also that a result that is not significant indicates that there is not enough evidence to declare that anything more than chance or random variation within the same population is at work between the two data sets being compared.

Demonstrator X achieves the following overall results after surveying each of the three progressively more difficult areas using the same system (results indicate the number of ordnance detected divided by the number of ordnance emplaced):

	Blind Grid	Open Field	Moguls
P_d^{res}	100/100 = 1.0	8/10 = .80	20/33 = .61
P_d^{disc}	80/100 = 0.80	6/10 = .60	8/33 = .24

P_d^{res}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the response stage, all 100 ordnance out of 100 emplaced ordnance items were detected in the blind grid while 8 ordnance out of 10 emplaced were detected in the open field. Fischer's test must be used since a 100 percent success rate occurs in the data. Fischer's test uses the four input values to calculate a test statistic of 0.0075 that is compared against the critical value of 0.05. Since the test statistic is less than the critical value, the smaller response stage detection rate (0.80) is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the detection ability of demonstrator X's system seems to have been degraded in the open field relative to results from the blind grid using the same system.

P_d^{disc}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the discrimination stage, 80 out of 100 emplaced ordnance items were correctly discriminated as ordnance in blind grid testing while 6 ordnance out of 10 emplaced were correctly discriminated as such in open field-testing. Those four values are used to calculate a test statistic of 1.12. Since the test statistic is less than the critical value of 2.71, the two discrimination stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{res}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the response stage, 8 out of 10 and 20 out of 33 are used to calculate a test statistic of 0.56. Since the test statistic is less than the critical value of 2.71, the two response stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{disc}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the discrimination stage, 6 out of 10 and 8 out of 33 are used to calculate a test statistic of 2.98. Since the test statistic is greater than the critical value of 2.71, the smaller discrimination stage detection rate is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the ability of demonstrator X to correctly discriminate seems to have been degraded by the mogul terrain relative to results from the flat open field using the same system.

APPENDIX B. DAILY WEATHER LOGS

TABLE B-1. WEATHER LOG

Date	Time, HH:MM	Temperature (^oF)	R/H, %	Precipitation, (in.)
2003-10-28	2:00	65.64	15	0.00
2003-10-28	3:00	62.76	16	0.00
2003-10-28	4:00	61.83	17	0.00
2003-10-28	5:00	62.01	18	0.00
2003-10-28	6:00	59.86	19	0.00
2003-10-28	7:00	60.35	20	0.00
2003-10-28	8:00	63.12	20	0.00
2003-10-28	9:00	71.33	15	0.00
2003-10-28	10:00	78.94	13	0.00
2003-10-28	11:00	82.76	12	0.00
2003-10-28	12:00	86.43	11	0.00
2003-10-28	13:00	89.37	10	0.00
2003-10-28	14:00	91.02	10	0.00
2003-10-28	15:00	93.04	9	0.00
2003-10-28	16:00	93.78	9	0.00
2003-10-28	17:00	92.84	10	0.00
2003-10-28	18:00	88.97	12	0.00
2003-10-28	19:00	84.58	13	0.00
2003-10-28	20:00	82.54	13	0.00
2003-10-28	21:00	77.09	14	0.00
2003-10-28	22:00	75.78	15	0.00
2003-10-28	23:00	71.92	24	0.00
2003-10-28	24:00	69.57	23	0.00
2003-10-29	1:00	70.23	27	0.00
2003-10-29	2:00	69.30	29	0.00
2003-10-29	3:00	68.20	34	0.00
2003-10-29	4:00	67.23	36	0.00
2003-10-29	5:00	67.01	38	0.00
2003-10-29	6:00	65.46	42	0.00
2003-10-29	7:00	68.27	47	0.00
2003-10-29	8:00	67.60	55	0.00
2003-10-29	9:00	70.36	46	0.00
2003-10-29	10:00	72.52	39	0.00
2003-10-29	11:00	76.87	36	0.00
2003-10-29	12:00	82.27	39	0.00
2003-10-29	13:00	84.42	33	0.00

TABLE B-1. (CONT'D)

Date	Time, HH:MM	Temperature (^{o}F)	R/H, %	Precipitation, (in.)
2003-10-29	14:00	87.82	26	0.00
2003-10-29	15:00	88.50	24	0.00
2003-10-29	16:00	88.83	21	0.00
2003-10-29	17:00	88.38	26	0.00
2003-10-29	18:00	86.09	29	0.00
2003-10-29	19:00	82.92	34	0.00
2003-10-29	20:00	79.86	37	0.00
2003-10-29	21:00	77.20	41	0.00
2003-10-29	22:00	74.68	48	0.00
2003-10-29	23:00	72.09	50	0.00
2003-10-29	24:00	69.93	53	0.00
2003-10-30	1:00	68.38	63	0.00
2003-10-30	2:00	68.04	69	0.00
2003-10-30	3:00	66.49	72	0.00
2003-10-30	4:00	64.63	72	0.00
2003-10-30	5:00	63.55	74	0.00
2003-10-30	6:00	64.63	77	0.00
2003-10-30	7:00	64.74	78	0.00
2003-10-30	8:00	64.08	79	0.00
2003-10-30	9:00	70.36	55	0.00
2003-10-30	10:00	72.36	37	0.00
2003-10-30	11:00	75.02	35	0.00
2003-10-30	12:00	76.33	32	0.00
2003-10-30	13:00	77.61	31	0.00
2003-10-30	14:00	78.33	29	0.00
2003-10-30	15:00	79.23	28	0.00
2003-10-30	16:00	78.40	30	0.00
2003-10-30	17:00	77.59	30	0.00
2003-10-30	18:00	75.43	33	0.00
2003-10-30	19:00	73.13	36	0.00
2003-10-30	20:00	71.42	38	0.00
2003-10-30	21:00	68.74	43	0.00
2003-10-30	22:00	65.79	47	0.00
2003-10-30	23:00	65.30	47	0.00
2003-10-30	24:00	63.59	49	0.00
2003-10-31	1:00	62.06	51	0.00
2003-10-31	2:00	60.78	53	0.00
2003-10-31	3:00	60.62	53	0.00
2003-10-31	4:00	60.85	53	0.00

TABLE B-1. (CONT'D)

Date	Time, HH:MM	Temperature (^oF)	R/H, %	Precipitation, (in.)
2003-10-31	5:00	59.92	54	0.00
2003-10-31	6:00	59.92	54	0.00
2003-10-31	7:00	58.26	56	0.00
2003-10-31	8:00	57.60	57	0.00
2003-10-31	9:00	63.91	47	0.00
2003-10-31	10:00	65.59	42	0.00
2003-10-31	11:00	67.21	40	0.00
2003-10-31	12:00	68.72	38	0.00
2003-10-31	13:00	71.01	35	0.00
2003-10-31	14:00	72.16	34	0.00
2003-10-31	15:00	73.31	33	0.00
2003-10-31	16:00	73.00	32	0.00
2003-10-31	17:00	71.80	33	0.00
2003-10-31	18:00	69.76	34	0.00
2003-10-31	19:00	67.69	35	0.00
2003-10-31	20:00	65.88	36	0.00
2003-10-31	21:00	64.65	38	0.00
2003-10-31	22:00	64.20	38	0.00
2003-10-31	23:00	64.45	37	0.00
2003-10-31	24:00	64.53	37	0.00
2003-11-01	1:00	63.45	39	0.00
2003-11-01	2:00	62.69	41	0.00
2003-11-01	3:00	62.22	43	0.00
2003-11-01	4:00	62.06	42	0.00
2003-11-01	5:00	60.67	43	0.00
2003-11-01	6:00	61.30	42	0.00
2003-11-01	7:00	60.64	43	0.00
2003-11-01	8:00	60.49	43	0.00
2003-11-01	9:00	63.10	39	0.00
2003-11-01	10:00	66.65	33	0.00
2003-11-01	11:00	69.15	31	0.00
2003-11-01	12:00	69.91	31	0.00
2003-11-01	13:00	70.99	31	0.00
2003-11-01	14:00	73.85	30	0.00
2003-11-01	15:00	74.55	28	0.00
2003-11-01	16:00	74.70	27	0.00
2003-11-01	17:00	74.12	29	0.00
2003-11-01	18:00	72.10	33	0.00
2003-11-01	19:00	69.60	35	0.00

TABLE B-1. (CONT'D)

Date	Time, HH:MM	Temperature (^oF)	R/H, %	Precipitation, (in.)
2003-11-01	20:00	66.65	39	0.00
2003-11-01	21:00	64.90	42	0.00
2003-11-01	22:00	63.64	43	0.00
2003-11-01	23:00	63.10	44	0.00
2003-11-01	24:00	60.35	46	0.00
2003-11-02	1:00	59.90	47	0.00
2003-11-02	2:00	59.92	46	0.00
2003-11-02	3:00	59.68	46	0.00
2003-11-02	4:00	57.36	49	0.00
2003-11-02	5:00	56.98	49	0.00
2003-11-02	6:00	54.25	49	0.00
2003-11-02	7:00	52.99	52	0.00
2003-11-02	8:00	57.04	47	0.00
2003-11-02	9:00	62.78	44	0.00
2003-11-02	10:00	65.44	40	0.00
2003-11-02	11:00	68.85	36	0.00
2003-11-02	12:00	70.00	34	0.00
2003-11-02	13:00	71.44	31	0.00
2003-11-02	14:00	70.09	33	0.00
2003-11-02	15:00	68.68	34	0.00
2003-11-02	16:00	67.78	34	0.00
2003-11-02	17:00	67.75	33	0.00
2003-11-02	18:00	66.63	33	0.00
2003-11-02	19:00	65.21	33	0.00
2003-11-02	20:00	64.58	33	0.00
2003-11-02	21:00	63.39	36	0.00
2003-11-02	22:00	61.77	42	0.00
2003-11-02	23:00	60.31	45	0.00
2003-11-02	24:00	58.93	48	0.00
2003-11-03	1:00	58.57	44	0.00
2003-11-03	2:00	57.04	45	0.00
2003-11-03	3:00	56.30	45	0.00
2003-11-03	4:00	53.82	49	0.00
2003-11-03	5:00	54.32	48	0.00
2003-11-03	6:00	53.62	48	0.00
2003-11-03	7:00	53.69	47	0.00
2003-11-03	8:00	55.26	44	0.00
2003-11-03	9:00	58.17	41	0.00
2003-11-03	10:00	61.61	35	0.00

TABLE B-1. (CONT'D)

Date	Time, HH:MM	Temperature (^oF)	R/H, %	Precipitation, (in.)
2003-11-03	11:00	64.69	32	0.00
2003-11-03	12:00	65.41	32	0.00
2003-11-03	13:00	66.27	32	0.00
2003-11-03	14:00	67.33	29	0.00
2003-11-03	15:00	68.25	28	0.00
2003-11-03	16:00	68.13	27	0.00
2003-11-03	17:00	67.46	27	0.00
2003-11-03	18:00	65.91	30	0.00
2003-11-03	19:00	63.72	33	0.00
2003-11-03	20:00	62.13	34	0.00
2003-11-03	21:00	60.15	37	0.00
2003-11-03	22:00	59.52	39	0.00
2003-11-03	23:00	56.79	44	0.00
2003-11-03	24:00	56.91	47	0.00
2003-11-04	1:00	54.28	51	0.00
2003-11-04	2:00	55.49	53	0.00
2003-11-04	3:00	52.99	56	0.00
2003-11-04	4:00	50.79	62	0.00
2003-11-04	5:00	52.66	63	0.00
2003-11-04	6:00	51.39	66	0.00
2003-11-04	7:00	47.80	67	0.00
2003-11-04	8:00	51.37	62	0.00
2003-11-04	9:00	57.65	55	0.00
2003-11-04	10:00	60.62	48	0.00
2003-11-04	11:00	63.50	38	0.00
2003-11-04	12:00	65.64	33	0.00
2003-11-04	13:00	66.88	31	0.00
2003-11-04	14:00	67.57	29	0.00
2003-11-04	15:00	69.42	26	0.00
2003-11-04	16:00	69.31	27	0.00
2003-11-04	17:00	68.83	27	0.00
2003-11-04	18:00	66.58	33	0.00
2003-11-04	19:00	64.29	35	0.00
2003-11-04	20:00	62.31	37	0.00
2003-11-04	21:00	59.70	41	0.00
2003-11-04	22:00	57.22	42	0.00
2003-11-04	23:00	53.87	43	0.00
2003-11-04	24:00	52.23	45	0.00
2003-11-05	1:00	50.90	47	0.00

TABLE B-1. (CONT'D)

Date	Time, HH:MM	Temperature (°F)	R/H, %	Precipitation, (in.)
2003-11-05	2:00	49.35	47	0.00
2003-11-05	3:00	48.38	51	0.00
2003-11-05	4:00	46.58	48	0.00
2003-11-05	5:00	45.10	48	0.00
2003-11-05	6:00	44.98	51	0.00
2003-11-05	7:00	46.62	52	0.00
2003-11-05	8:00	49.50	51	0.00
2003-11-05	9:00	57.15	42	0.00
2003-11-05	10:00	64.33	31	0.00
2003-11-05	11:00	66.29	29	0.00
2003-11-05	12:00	69.53	26	0.00
2003-11-05	13:00	70.09	25	0.00
2003-11-05	14:00	71.82	23	0.00
2003-11-05	15:00	73.11	21	0.00
2003-11-05	16:00	73.65	20	0.00
2003-11-05	17:00	72.68	20	0.00
2003-11-05	18:00	70.14	21	0.00
2003-11-05	19:00	67.89	22	0.00
2003-11-05	20:00	64.02	25	0.00
2003-11-05	21:00	63.01	26	0.00
2003-11-05	22:00	60.13	29	0.00
2003-11-05	23:00	57.81	30	0.00
2003-11-05	24:00	53.87	30	0.00
2003-11-06	1:00	52.18	32	0.00
2003-11-06	2:00	52.03	34	0.00
2003-11-06	3:00	50.58	35	0.00
2003-11-06	4:00	48.34	37	0.00
2003-11-06	5:00	48.85	39	0.00
2003-11-06	6:00	47.93	40	0.00
2003-11-06	7:00	47.73	44	0.00
2003-11-06	8:00	53.42	38	0.00
2003-11-06	9:00	61.84	29	0.00
2003-11-06	10:00	64.06	27	0.00
2003-11-06	11:00	69.28	23	0.00
2003-11-06	12:00	70.75	22	0.00
2003-11-06	13:00	72.32	21	0.00
2003-11-06	14:00	74.43	19	0.00
2003-11-06	15:00	74.03	19	0.00
2003-11-06	16:00	75.04	18	0.00

TABLE B-1. (CONT'D)

Date	Time, HH:MM	Temperature (^oF)	R/H, %	Precipitation, (in.)
2003-11-06	17:00	74.39	18	0.00
2003-11-06	18:00	71.56	20	0.00
2003-11-06	19:00	68.04	22	0.00
2003-11-06	20:00	64.33	24	0.00
2003-11-06	21:00	62.60	25	0.00
2003-11-06	22:00	60.35	27	0.00
2003-11-06	23:00	61.30	26	0.00
2003-11-06	24:00	56.84	29	0.00

APPENDIX C. SOIL MOISTURE

Date	Time	CALIBRATION AREA (%)					Time	MOGUL AREA (%)					Time	EXTREME AREA (%)				
		0 - 6"	6 -12"	12-24"	24-36"	36-48"		0 - 6"	6 -12"	12-24"	24-36"	36-48"		0 - 6"	6 -12"	12-24"	24-36"	36-48"
10/28/2003	955	1.8	2.3	3.7	3.6	4.0	1004	1.7	2.0	3.5	4.0	4.1	1013	1.6	2.1	3.4	4.0	4.2
	1405	1.8	2.2	3.7	3.6	4.0	1413	1.7	2.0	3.5	4.0	4.1	1420	1.6	2.1	3.4	4.0	4.1
10/29/2003	705	1.8	2.3	3.7	3.6	4.0	713	1.7	2.0	3.6	3.9	4.0	719	1.6	2.1	3.4	4.0	4.1
	1300	1.8	2.3	3.7	3.6	4.0	1310	1.7	2.0	3.6	3.9	4.0	1318	1.6	2.1	3.4	4.0	4.1
10/30/2003	730	1.8	2.3	3.7	3.6	4.0	738	1.7	2.0	3.5	3.9	4.0	745	1.6	2.1	3.4	4.0	4.2
	1502	1.8	2.3	3.7	3.6	4.0	1513	1.8	2.0	3.6	4.0	4.1	1518	1.6	2.1	3.4	4.0	4.1
10/31/2003	651	1.8	2.3	3.7	3.6	4.0	703	1.6	2.0	3.5	3.9	4.0	712	1.6	2.1	3.4	4.0	4.2
	1422	1.8	2.3	3.7	3.6	4.0	1434	1.7	2.0	3.6	3.9	4.1	1444	1.6	2.1	3.4	3.9	4.1
11/3/2003	650	1.8	2.3	3.7	3.6	4.0	659	1.7	2.0	3.6	3.9	4.0	707	1.6	2.1	3.4	3.9	4.1
	1400	1.8	2.3	3.7	3.6	4.0	1408	1.7	2.0	3.6	3.9	4.0	1419	1.6	2.1	3.4	3.9	4.1
11/4/2003	635	1.8	2.3	3.7	3.6	4.0	643	1.7	2.0	3.6	3.9	4.1	650	1.6	2.1	3.4	3.9	4.1
	1340	1.8	2.3	3.7	3.6	4.0	1348	1.7	2.0	3.5	3.9	4.1	1357	1.6	2.1	3.4	3.9	4.1
11/5/2003	645	1.8	2.3	3.7	3.6	4.0	653	1.7	2.0	3.5	3.9	4.0	701	1.6	2.1	3.4	3.9	4.1
	1420	1.8	2.3	3.7	3.6	4.0	1429	1.7	2.0	3.6	3.9	4.0	1438	1.6	2.1	3.4	3.9	4.1
11/6/2003	640	1.8	2.3	3.7	3.6	4.0	648	1.7	2.0	3.5	3.9	4.0	657	1.6	2.0	3.4	3.9	4.1
	1400	1.8	2.3	3.7	3.6	4.0	1408	1.7	2.0	3.5	3.9	4.0	1415	1.6	2.0	3.4	3.9	4.1

APPENDIX D. DAILY ACTIVITY LOGS

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031028	3	INITIAL SETUP	930	1140	130	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031028	2	CALIBRATION LANE	1140	1150	10	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	HOT	DRY
20031028	2	CALIBRATION LANE	1150	1215	25	COLLECTING DATA	RUNNING CALIBRATION LANE NORTH/ SOUTH	GPS	LINER	HOT	DRY
20031028	2	CALIBRATION LANE	1215	1220	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031028	3	CALIBRATION LANE	1220	1234	14	BREAK/LUNCH	LUNCH	NA	NA	HOT	DRY
20031028	2	BLIND TEST GRID	1234	1310	36	COLLECTING DATA	RUNNING BTG NORTH/ SOUTH	GPS	LINER	HOT	DRY
20031028	3	BLIND TEST GRID	1310	1320	10	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY
20031028	3	OPEN RANGE	1320	1420	60	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031028	2	OPEN RANGE	1420	1519	59	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031028	3	OPEN RANGE	1519	1533	14	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031028	2	OPEN RANGE	1533	1636	63	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031028	3	OPEN RANGE	1636	1700	24	SETUP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	HOT	DRY
20031029	3	OPEN RANGE	655	730	35	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	730	735	5	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	HOT	DRY
20031029	3	OPEN RANGE	735	758	23	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	758	852	54	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	852	858	6	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	858	950	52	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	3	OPEN RANGE	950	954	4	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	954	1011	17	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1011	1106	55	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	1106	1111	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1111	1130	19	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031029	3	OPEN RANGE	1130	1138	8	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED MAIN COMPUTER	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1138	1233	55	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	1233	1238	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1238	1302	24	BREAK/LUNCH	LUNCH	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1302	1356	54	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	1356	1400	4	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1400	1500	60	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	1500	1505	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1505	1528	23	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY
20031029	2	OPEN RANGE	1528	1605	37	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	1605	1611	6	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	HOT	DRY
20031029	2	OPEN RANGE	1611	1640	29	SETUP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	HOT	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031030	2	OPEN RANGE	650	753	63	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	753	756	3	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	756	815	19	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	815	905	50	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	905	910	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	910	945	35	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	945	950	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	950	1015	25	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	1015	1057	42	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	1057	1146	49	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	1146	1155	9	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	1155	1250	55	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031030	2	OPEN RANGE	1250	1314	24	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	1314	1412	58	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	1412	1415	3	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	1415	1530	75	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	1530	1535	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031030	2	OPEN RANGE	1535	1620	45	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031030	2	OPEN RANGE	1620	1645	25	SETUP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	645	756	71	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	756	852	56	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031031	2	OPEN RANGE	852	859	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	859	921	22	DOWNTIME DUE TO EQUIPMENT FAILURE	FLASH CARD BAD CHECKED MEMORY CARD	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	921	1014	53	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031031	2	OPEN RANGE	1014	1029	15	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	1029	1119	50	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031031	2	OPEN RANGE	1119	1129	10	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	1129	1221	52	COLLECTING DATA	RUNNING OPEN RANGE NORTH /SOUTH	GPS	LINER	HOT	DRY
20031031	2	OPEN RANGE	1221	1248	27	BREAK/LUNCH	BREAK	NA	NA	HOT	DRY
20031031	2	MOGUL AREA	1248	1615	207	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031031	2	OPEN RANGE	1615	1648	33	COLLECTING DATA	RUNNING OPEN RANGE EAST/ WEST	GPS	LINER	HOT	DRY
20031031	2	OPEN RANGE	1648	1710	22	SETUP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	HOT	DRY
20031103	2	MOGUL AREA	625	719	54	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031103	2	MOGUL AREA	719	722	3	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	COOL	DRY
20031103	2	MOGUL AREA	722	755	33	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031103	2	MOGUL AREA	755	847	52	COLLECTING DATA	RUNNI9NG MOGUL AREA NORTH /SOUTH	GPS	LINER	COOL	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031103	2	MOGUL AREA	847	852	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031103	2	MOGUL AREA	852	1000	68	COLLECTING DATA	RUNNING MOGUL AREA NORTH/SOUTH	GPS	LINER	COOL	DRY
20031103	2	MOGUL AREA	1000	1013	13	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031103	2	MOGUL AREA	1013	1115	62	COLLECTING DATA	RUNNING MOGUL AREA NORTH/SOUTH	GPS	LINER	COOL	DRY
20031103	2	MOGUL AREA	1115	1135	20	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031103	2	MOGUL AREA	1135	1207	32	BREAK/LUNCH	LUNCH	NA	NA	COOL	DRY
20031103	2	YUMA EXTREME	1207	1210	3	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	COOL	DRY
20031103	2	YUMA EXTREME	1210	1230	20	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031103	2	YUMA EXTREME	1230	1325	55	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031103	2	YUMA EXTREME	1325	1337	12	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031103	2	YUMA EXTREME	1337	1433	56	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031103	2	YUMA EXTREME	1433	1438	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031103	2	YUMA EXTREME	1438	1505	27	BREAK/LUNCH	BREAK	NA	NA	COOL	DRY
20031103	2	YUMA EXTREME	1505	1608	63	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031103	2	YUMA EXTREME	1608	1635	27	SETUP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	COOL	DRY
20031104	2	YUMA EXTREME	630	722	52	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031104	2	YUMA EXTREME	722	727	5	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	COOL	DRY
20031104	2	YUMA EXTREME	727	745	18	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031104	2	YUMA EXTREME	745	840	55	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031104	2	YUMA EXTREME	840	845	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031104	2	YUMA EXTREME	845	950	65	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031104	2	YUMA EXTREME	950	1001	11	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031104	2	YUMA EXTREME	1001	1110	69	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031104	2	YUMA EXTREME	1110	1120	10	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031104	2	YUMA EXTREME	1120	1200	50	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031104	2	YUMA EXTREME	1200	1310	70	BREAK/LUNCH	LUNCH	NA	NA	COOL	DRY
20031104	2	YUMA EXTREME	1310	1400	50	DOWNTIME DUE TO EQUIP MAINT/CHECK	CHECKING/DOWNLOADING DATA	NA	NA	COOL	DRY
20031104	2	MOGUL AREA	1400	1428	28	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031104	2	MOGUL AREA	1428	1448	20	COLLECTING DATA	RUNNING MOGUL AREA NORTH/SOUTH	GPS	LINER	COOL	DRY
20031104	2	OPEN RANGE	1448	1520	32	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031104	2	OPEN RANGE	1520	1550	30	COLLECTING DATA	RUNNING OPEN RANGE EAST/WEST	GPS	LINER	COOL	DRY
20031104	2	OPEN RANGE	1550	1620	30	SET-UP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	COOL	DRY
20031105	2	OPEN RANGE	635	718	43	SET-UP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031105	2	OPEN RANGE	718	721	3	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	COOL	DRY
20031105	2	OPEN RANGE	721	727	6	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031105	2	OPEN RANGE	727	815	48	COLLECTING DATA	RUNNING OPEN RANGE EAST/WEST	GPS	NA	COOL	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031105	2	OPEN RANGE	815	820	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031105	2	OPEN RANGE	820	905	45	COLLECTING DATA	RUNNING OPEN RANGE EAST/WEST	GPS	LINER	COOL	DRY
20031105	2	OPEN RANGE	905	910	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	COOL	DRY
20031105	2	OPEN RANGE	910	940	30	COLLECTING DATA	RUNNING OPEN RANGE EAST/WEST	GPS	LINER	COOL	DRY
20031105	2	MOGUL AREA	940	1000	20	DOWNTIME DUE TO EQUIP MAINT/CHECK	CHECKING/DOWNLOADING DATA	NA	NA	COOL	DRY
20031105	2	MOGUL AREA	1000	1015	15	BREAK/LUNCH	BREAK	NA	NA	COOL	DRY
20031105	2	MOGUL AREA	1015	1020	5	SET-UP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031105	2	MOGUL AREA	1020	1152	92	COLLECTING DATA	RUNNING MOGUL AREA NORTH/SOUTH	GPS	LINER	HOT	DRY
20031105	2	YUMA EXTREME	1152	1220	28	SET-UP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	HOT	DRY
20031105	2	YUMA EXTREME	1220	1305	45	BREAK/LUNCH	LUNCH	NA	NA	HOT	DRY
20031105	2	YUMA EXTREME	1305	1359	54	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	HOT	DRY
20031105	2	YUMA EXTREME	1359	1415	16	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031105	2	YUMA EXTREME	1415	1510	55	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	HOT	DRY
20031105	2	YUMA EXTREME	1510	1520	10	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031105	2	YUMA EXTREME	1520	1545	25	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	HOT	DRY
20031105	2	YUMA EXTREME	1545	1625	40	SETUP/MOBILIZATION	EQUIPMENT BREAKDOWN EOD	NA	NA	HOT	DRY
20031106	2	YUMA EXTREME	630	708	38	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031106	2	YUMA EXTREME	708	711	3	COLLECTING DATA	SIX LANE CALIBRATION WITH BOLTS	GPS	LINER	COOL	DRY
20031106	2	YUMA EXTREME	711	732	21	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031106	2	YUMA EXTREME	732	814	42	COLLECTING DATA	RUNNING YUMA EXTREME NORTH /SOUTH	GPS	LINER	COOL	DRY
20031106	2	CALIBRATION LANE	814	900	46	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY
20031106	2	CALIBRATION LANE	900	938	38	COLLECTING DATA	RUNNING CALIBRATION LANE NORTH/ SOUTH	GPS	LINER	COOL	DRY
20031106	2	CALIBRATION LANE	938	956	18	BREAK/LUNCH	BREAK	NA	NA	COOL	DRY
20031106	2	CALIBRATION PIT	956	1037	41	SETUP/MOBILIZATION	SETTING UP EQUIPMENT FOR TESTING	NA	NA	COOL	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031106	2	CALIBRATION PIT	1037	1102	25	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 155 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1102	1109	7	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON ATC 105 MM	GPS	NA	HOT	DRY
20031106	2	CALIBRATION PIT	1109	1115	6	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 105 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1115	1120	5	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 81 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1120	1122	2	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 2.75 INCH	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1122	1125	3	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED BATTERY	NA	NA	HOT	DRY
20031106	2	CALIBRATION PIT	1125	1135	10	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON MK 118	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1135	1141	6	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 60 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1141	1148	7	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 57 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1148	1156	8	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON BDU 28	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1156	1202	6	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 40 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1202	1206	4	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON BLU-26	GPS	LINER	HOT	DRY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status-Comments	Track Method	Pattern	Field Conditions	
20031106	2	CALIBRATION PIT	1206	1214	8	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON M-42	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1214	1220	6	COLLECTING DATA	RUNNING SIGNATURE DATA NORTH/SOUTH ON 20 MM	GPS	LINER	HOT	DRY
20031106	2	CALIBRATION PIT	1220	1300	40	DOWNTIME DUE TO EQUIP MAINT/CHECK	CHECKING/DOWNLOADING DATA	NA	NA	HOT	DRY
20031106	2	CALIBRATION PIT	1300	1540	160	DEMOBILIZATION	END OF TEST	NA	NA	HOT	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

APPENDIX E. REFERENCES

1. Standardized UXO Technology Demonstration Site Handbook, DTC Project No. 8-CO-160-000-473, Report No. ATC-8349, March 2002.

2. Aberdeen Proving Ground Soil Survey Report, October 1998.

3. Data Summary, UXO Standardized Test Site: APG Soils Description, May 2002.

4. Yuma Proving Ground Soil Survey Report, May 2003.

5. Practical Nonparametric Statistics, W.J. Conover, John Wiley & Sons, 1980, pages 144 through 151.

APPENDIX F.   ABBREVIATIONS

ACSII	=	American Standard Code for Information Interchange
AEC	=	U.S. Army Environmental Center
APG	=	Aberdeen Proving Ground
ATC	=	U.S. Army Aberdeen Test Center
ATSS	=	Aberdeen Test and Support Services
BTG	=	Blind Test Grid
CD	=	compact disc
CEP	=	Central error Probability
DGPS	=	differential Global Positioning System
DOD	=	Department of Defense
ERDC	=	U.S. Army Corps of Engineers Engineering Research and Development Center
ESTCP	=	Environmental Security Technology Certification Program
EQT	=	Army Environmental Quality Technology Program
GPS	=	Global Positioning System
GX	=	GEOSOFT executable
HEAT	=	high-explosive, antitank
JPG	=	Jefferson Proving Ground
LLC	=	Limited liability Company
MAG	=	magnetometer
METDC	=	Military Environmental Technology Demonstration Center
MS	=	Microsoft
NMEA	=	National Maritime Electronics Association
PC	=	personal computer
P_d	=	probability of detection
POC	=	point of contact
QA	=	quality assurance
QC	=	quality control
rms	=	root mean square
ROC	=	receiver-operating characteristic
RTK	=	real-time kinematic
SERDP	=	Strategic Environmental Research and Development Program
UXO	=	unexploded ordnance
YPG	=	U.S. Army Yuma Proving Ground